US-PAT-NO: 4594665

DOCUMENT-IDENTIFIER: US 4594665 A

TITLE: Well production control system

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US Patent No. - PN (1):
4594665

Detailed Description Text - DETX (4):
The load cell 47 provides a DC output signal which is proportional to the load on the sucker-rod string 16, and an analog-to-digital converter 48 provides a corresponding digital signal to a computer 49a. A position measuring means or transducer 53 measures the vertical position of the sucker-rod string 16 by providing a voltage which is proportional to the angle of the walking beam 22 and thus is proportional to the position of the rod string 16. The digital-to-analog converter 48 also converts the signal from the transducer 53 into a digital signal which is used by the computer 49a and by an XY plotter 54. Signals are transferred between the computer 49a and a computer 49b by a pair of wires 55a, 55b. Instructi ns from a

keyb ard 60 and
from a ontrol and display unit 61 and output signals from the load ell 47 ar
used by the XY plotter to provide a visual plot of the characteristics of the
particular well which the rod string operates. The plotter 54 can be used for
observing operation of the well and for setting up the equipment to monitor the
well. After setup is completed the plotter can be disconnected, or if desired
the plotter can be eliminated altogether and the display unit 61 or other means
for setting up the equipment can be used.

Detailed Description Text - DETX (18):

The portion of the computer system disclosed in FIG. 6A comprises a motor
controller 71 for receiving signals from the load cell 47 and from transducer
53 and for using these signals to determine the sequence for controlling the
motor 30. The computer 49b disclosed in FIG. 6B comprises a display programmer
72 for using the load cell and transducer signals transmitted from computer 49a
to operate the XY plotter 54. Signals are interchanged between the motor
controller 71 and the display programmer 72 over the pair of interconnecting
wires 55a, 55b.

Detailed Description Text - DETX (20):

Clock pulses for driving the micr c ntr llers are stabilized by a

pair of
crystals 81a, 81b. The contr ller 73a is c nn ct d to a p wer reset circuit 82
to warn .ha. power to the controller is failing. An indicating device 83a
receives visual display information from an input/output interface 84 and the
graphic display 61 receives visual display information from a display
controller 85. Programs for operating the motor controller 71 and the plotter
programmer 72 are stored in the PROMS 74a, 74b and data for use in the system
is stored in the RAMS 75a, 75b. A load/stroke conditioner 88 (FIG. 6A)
amplifies and filters signals transmitted from the load cell 47 and the
transducer 53 and sends the smoothed signals to the bus 80a through a
multiplexer 89 and the analog-to-digital converter 48. A buffer 87 (FIGS. 1,
6A) provides signals to operate the XY plotter 54 in response to signals from
the multiplexer 89. An analog-to-digital converter which can be used is the
model AD574A manufactured by Analog Devices.

US-PAT-NO: 5406482

DOCUMENT-IDENTIFIER: US 5406482 A

TITLE: Method and apparatus for measuring pumping rod position and other aspects of a pumping system by use of an accelerometer

--------- KWIC --------

10/744,683

US Patent No. - PN (1):
5406482

10/744
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713

Brief Summary Text - BSTX (12):
In a still further aspect of the present invention, the output from an accelerometer mounted on a pumping system is displayed on the screen of a computer to indicate operation of the pumping system, including any anomalies in the operation such as unusual vibrations or pounding.

Drawing Description Text - DRTX (9):
FIG. 7A is an accelerometer output waveform produced on a screen display showing normal operation of a pumping system and FIG. 7B is an accelerometer output waveform displayed on a screen which indicates abnormal vibrati ns and

therefore abnormal operation of a pumping system, and

Detailed Description Text - DETX (20):

The waveforms shown in FIGS. 4A-4D, 5A and 5B are displayed on the display screen 52 of the computer 50, shown in FIG. 1. This allows the operator to see the signals which have been collected, and those which have been processed.

Detailed Description Text - DETX (21):

In a prior technique, the load on a polished rod was acquired and displayed as a function of the polished rod position. This used mechanical test equipment in which the display of polished rod load versus polished rod position was produced by rotating a drum on which the load was scribed. To produce a display, such as shown in FIG. 5A, the load on the rod and the position of the rod must both be known.

Detailed Description Text - DETX (27):

A still further aspect of the present invention is the utilization of an accelerometer for the observation of pumping system performance as illustrated in FIGS. 7A and 7B. FIG. 7A represents the output signal from the accelerometer 40 for a pumping system, such as shown in FIG. 1, in which the operation is normal. This is indicated by the generally smooth acc l rati n

curve. FIG. 7B is the output signal fr m the accelerometer 40 f r the same or
similar pumping unit, but with improper peration. The signal in FIG. 7B
includes abnormal vibrations indicated by the lines 102, 104 and 106. These
abnormal vibrations are essentially repeated in each of the cycles of the
signal. Such vibrations can be generated by defective gear teeth, worn
bearings, abnormal surface conditions, unit misalignment, abnormal downhole
pump conditions, and downhole mechanical problems. These large acceleration
spikes (lines 102, 104 and 106) in the acceleration signal indicate that severe
shock loads occur at these times. FIGS. 7A and 7B are displayed concurrently
on the screen 52 of the computer 50 so the abnormalities can be readily
determined. The signal in FIG. 7A can be recorded at a time when it is known
that the pumping system is working well or it can be a representative signal
for a pumping unit of the particular type which is to be examined.

Claims Text - CLTX (9):

3. A method for measuring the position of a rod as recited in claim 1
further including the step of displaying on a computer screen one or more
waveforms corresponding to either said first signal, said second signal or said
third signal.

Claims Text - CLTX (17):

7. A method for m asuring the p sition of a rod as r cited in claim 4
further including the step of displaying on a computer screen one or more
waveforms corresponding to either said first signal, said second signal, or
said third signal.

Claims Text - CLTX (28):

11. A method for measuring the position of a rod as recited in claim 8
further including the step of displaying on a computer screen one or more
waveforms corresponding to either said first signal, said second signal, or
said third signal.

US-PAT-N : 5464058

DOCUMENT-IDENTIFIER: US 5464058 A

TITLE: Method of using a polished rod transducer

--------- KWIC --------

Brief Summary Text - BSTX (16):

Still a further object of the present invention is the utilization of computers and computer software to process and display the data generated by the novel polished rod transducer. Such useful display screens include displays of the raw change in polished rod load data, surface cards (polished rod load versus cycle position), surface cards showing absolute polished rod load, downhole cards showing change in pump load versus cycle position, and downhole cards showing absolute pump loading.

Detailed Description Text - DETX (66):

FIG. 19 shows a surface dynamometer card obtained from transducer 60 data. The transducer 60 acquired surface data was used to calculate the downhole card shown in FIG. 20. The minimum load value was set to zero. The same offset used on the downhole card was used on the surface data to display a surface

card. N te that an operator can visually analyze that the d wnh le pump is less than one-half full of liquid.

Detailed Description Text - DETX (69):

Following display operation block 304, operation is transferred to block 306 to generate a surface card of uncalibrated rod load versus rod position (see FIG. 15). Next, in block 308 the uncalibrated surface card is displayed on the computer screen.

Detailed Description Text - DETX (70):

After display in block 308 operation is transferred to block 310 to generate from the surface card a downhole card which shows uncalibrated pump load versus pump position (see FIG. 17). This is determined as set forth in the article by Gibbs noted above. This uncalibrated downhole card is then displayed on the computer screen as set forth in block 320.

Detailed Description Text - DETX (72):

In step 323 the calibrated downhole card is shown on the computer display screen.

Claims Text - CLTX (26):

14. A method for determining absolute load on a polished rod as recited in

laim 12 including the step of displaying said abs lut value surface card on a display screen.

US-PAT-NO: 5589633

DOCUMENT-IDENTIFIER: US 5589633 A
****See image for Certificate of Correction****

TITLE: Method and apparatus for measuring pumping rod position and other aspects of a pumping system by use of an accelerometer

---------- KWIC --------

US Patent No. - PN (1):
5589633

Brief Summary Text - BSTX (12):
In a still further aspect of the present invention, the output from an accelerometer mounted on a pumping system is displayed on the screen of a computer to indicate operation of the pumping system, including any anomalies in the operation such as unusual vibrations or pounding.

Drawing Description Text - DRTX (9):
FIG. 7A is an accelerometer output waveform produced on a screen display showing normal operation of a pumping system and FIG. 7B is an accelerometer utput waveform displayed on a scr en which indicates abnormal

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ther f r abn rmal op rati n of a pumping. system, and

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The waveforms shown in FIGS. 4A-4D, 5A and 5B are displayed on the display
screen 52 of the computer 50, shown in FIG. 1. This allows the operator to see
the signals which have been collected, and those which have been processed.

Detailed Description Text - DETX (21):
In a prior technique, the load on a polished rod was acquired and displayed
as a function of the polished rod position. This used mechanical test
equipment in which the display of polished rod load versus polished rod
position was produced by rotating a drum on which the load was scribed. To
produce a display, such as shown in FIG. 5A, the load on the rod and the
position of the rod must both be known.

Detailed Description Text - DETX (27):
A still further aspect of the present invention is the utilization of an
accelerometer for the observation of pumping system performance as illustrated
in FIGS. 7A and 7B. FIG. 7A represents the output signal from the accelerometer 40 for a pumping system, such as shown in FIG. 1, in which the
perati n is n rmal. This is indicated by the generally sm oth

acceleration
urve. FIG. 7B is the output signal from the acceler meter 40 f r the same r
similar pumping unit, but with improper operation. The signal in FIG. 7B
includes abnormal vibrations indicated by the lines 102, 104 and 106. These
abnormal vibrations are essentially repeated in each of the cycles of the
signal. Such vibrations can be generated by defective gear teeth, worn
bearings, abnormal surface conditions, unit misalignment, abnormal downhole
pump conditions, and downhole mechanical problems. These large acceleration
spikes (lines 102, 104 and 106) in the acceleration signal indicate that severe
shock loads occur at these times. FIGS. 7A and 7B are displayed concurrently
on the screen 52 of the computer 50 so the abnormalities can be readily
determined. The signal in FIG. 7A can be recorded at a time when it is known
that the pumping system is working well or it can be a representative signal
for a pumping unit of the particular type which is to be examined.

Claims Text - CLTX (5):
displaying said first digital data set as a waveform on a display screen of
said computer wherein said waveform includes features indicating performance of
said pumping system.

Claims Text - CLTX (8):

displaying at l ast ne marker on said screen in c njunction with said waveform .o indica.e a position of said rod.

Claims Text - CLTX (9):

3. A method for analyzing the performance of a pumping system as recited in claim 1 including concurrently displaying on said screen a second waveform representing the output signal for said accelerometer for normal operation of said pumping system.

US-PAT-NO: 5406482

DOCUMENT-IDENTIFIER: US 5406482 A

TITLE: Method and apparatus for measuring pumping rod position and other aspects of a pumping system by use of an accelerometer

---------- KWIC ----------

US Patent No. - PN (1):
5406482

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FIG. 7A is an accelerometer output waveform produced on a screen display showing normal operation of a pumping system and FIG. 7B is an accelerometer output waveform displayed on a screen which indicates abnormal vibrati ns and

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The waveforms shown in FIGS. 4A-4D, 5A and 5B are displayed on the display screen 52 of the computer 50, shown in FIG. 1. This allows the operator to see the signals which have been collected, and those which have been processed.

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In a prior technique, the load on a polished rod was acquired and displayed as a function of the polished rod position. This used mechanical test equipment in which the display of polished rod load versus polished rod position was produced by rotating a drum on which the load was scribed. To produce a display, such as shown in FIG. 5A, the load on the rod and the position of the rod must both be known.

Detailed Description Text - DETX (27):

A still further aspect of the present invention is the utilization of an accelerometer for the observation of pumping system performance as illustrated in FIGS. 7A and 7B. FIG. 7A represents the output signal from the accelerometer 40 for a pumping system, such as shown in FIG. 1, in which the operation is normal. This is indicated by the generally smooth accel ration

curve. FIG. 7B is the output signal fr m the accelerometer 40 for the same or
similar pumping unit, but with improper perati n. The signal in FIG. 7B
includes abnormal vibrations indicated by the lines 102, 104 and 106. These
abnormal vibrations are essentially repeated in each of the cycles of the
signal. Such vibrations can be generated by defective gear teeth, worn
bearings, abnormal surface conditions, unit misalignment, abnormal downhole
pump conditions, and downhole mechanical problems. These large acceleration
spikes (lines 102, 104 and 106) in the acceleration signal indicate that severe
shock loads occur at these times. FIGS. 7A and 7B are displayed concurrently
on the screen 52 of the computer 50 so the abnormalities can be readily
determined. The signal in FIG. 7A can be recorded at a time when it is known
that the pumping system is working well or it can be a representative signal
for a pumping unit of the particular type which is to be examined.

Claims Text - CLTX (9):

3. A method for measuring the position of a rod as recited in claim 1
further including the step of displaying on a computer screen one or more
waveforms corresponding to either said first signal, said second signal or said
third signal.

Claims Text - CLTX (17):

7. A meth d for m asuring th p siti n f a rod as recited in claim 4 further including the step of displaying on a computer screen one or more waveforms corresponding to either said first signal, said second signal, or said third signal.

Claims Text - CLTX (28):

11. A method for measuring the position of a rod as recited in claim 8 further including the step of displaying on a computer screen one or more waveforms corresponding to either said first signal, said second signal, or said third signal.